PROCTOR ENGINEERING GROUP

An Evaluation Of
Unitil's Residential Space Heat Program

for program operations from October 1994 through June 1995

submitted by:
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Introduction

Conservation Services Group (CSG) contracted with Proctor Engineering Group, a national research and evaluation company, to evaluate the savings of the Residential Space Heat Program that CSG operates for Unitil Service Corp.'s retail subsidiaries, Exeter & Hampton Electric Company, Concord Electric Company, and Fitchburg Gas and Electric Light Company. The Residential Space Heat Program was designed to capture the electricity conservation potential of residential units through direct installation of comprehensive electric-saving measures at no charge to the customer (except for attic ventilation if needed). The program targeted high-use electric space heat customers.

Program Description

The Residential Space Heat Program incorporates comprehensive, whole-building diagnostics and treatments to maximize the potential for energy-saving opportunities. During the period covered by this evaluation, the program provided 266 participating households with the following energy-savings services and measures for applications which passed a cost-effectiveness criteria:

- comprehensive technical assessment and diagnostics of the house
- blower door assisted air sealing
- duct blaster™ assisted duct sealing of heat pump systems
- attic, basement and wall insulation upgrades
- hot water efficiency measures, including electric water heater wraps, pipe insulation, faucet aerators, and showerheads
- compact fluorescent light bulbs
- window improvements when only one glazing exists
- electronic thermostats
- customer education on appliances and equipment operation

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Overall, about 69% of participants received air sealing, 31% received insulation upgrades, 94% received one or more compact fluorescent bulbs, and about 65% received hot water measures. Electronic thermostats were only installed in certain multifamily complexes. Low income customers represented 29% of the participants.

Methodology

The modest size of the program dictated that the evaluation should remain fairly straightforward and inexpensive and rely upon existing data. Based on the experiences during the previous evaluation performed by PEG in November 1995 which included two evaluation approaches, this evaluation used the PRInceton Scorekeeping Method (PRISM) to weather normalize the usage data of participants and a matched comparison sample. The usage levels and changes in usage were summarized in several ways to assess program savings. In addition, a follow-up study of previously evaluated program participants was performed to assess the persistence of savings.

Data Set and Sample Selection

The program had 266 participants during the period of October 1994 through June 1995. The usage database of all residential electric space heat customers developed during the prior evaluation was updated with usage data through mid-July 1996. Overall, 257 participants had enough billing history data available to perform the PRISM analysis. A comparison group selection procedure was developed to identify a group of customers who did not participate in the program but were similar in other respects. This procedure proved to be quite complex involving a number of screens and stratification variables.

Winter and summer usage rates in the year September 1993 through September 1994 were calculated and ranked on a scale of one to ten for all residential electric space heat customers (each rank corresponded to 10% of the customer base). Program recruitment had been targeted to higher use customers based on similar rankings performed previously and therefore the comparison group needed to have comparably high usage. To select a comparison group, the full space heat customer list was first screened to remove cases which were considered inappropriate because they:

- were identified as a business;
- were not considered a prospect for participation (e.g., had refused to participate);
- had incomplete billing histories;
- used less annual kWh than the lowest use participant;
- used more annual kWh than the highest use participant; or
- lived in a zip code which had no participants.

The participant group was then stratified so that a matching group of non-participants could be selected. The stratification variables were :

- retail affiliate;
- single vs. multi-family;
- winter usage ranking; and
- summer usage ranking (to facilitate matching, the ten categories were combined into three).

A total of 96 unique combinations of these factors were identified in the participant group. For each of these combinations (i.e., for each strata cell), comparison group customers were selected randomly to match the total number of participants in the same cell. To provide a better geographic component to the selection process, the odds of selecting each non-participant in a cell were proportional to the number of participants with the same first three zip code digits. Overall, this process resulted in a comparison group of 254 non-participants (out of the target sample size of 266, six slots could not be filled due to an insufficient number of matching non-participants and six selected cases had insufficient data for PRISM analysis).

Weather Normalization
The usage data were analyzed using PRISM to adjust for differences in weather between the pre and post retrofit periods. Comparison group cases were assigned pseudo-treatment dates for analysis by using the dates from the matched treatment cases in the same strata. The 12 (±1) months preceding treatment and the 12 (±1) months after treatment were analyzed for each case.

Data Screening
The region served by the program has a large percentage of households which use supplementary heating sources, particularly wood stoves (48% of all participants in single family homes had some type of supplementary heat). The presence of supplemental heating complicates the analysis because large changes in usage may occur which are due to changes in supplemental heat usage unrelated to the program. These large usage changes can overwhelm program effects and add tremendous variability into the data. To avoid such problems and provide more reliable savings estimates, several screening criteria were employed. First, 25 participant and 32 non-participant cases were removed from the analysis because they experienced a change in normalized usage of more than 40%. This screen may be considered somewhat conservative because it could remove some participant households who experienced large savings due to the program. Second, 51 participant and 46 non-participant cases were removed because the PRISM results indicated that there was a high levels of uncertainty in their normalized consumption estimate (defined here as a standard error of more than 10%). Another 23 participants and 5 non-participants were removed because they had short usage analysis periods (<330 days). In total, the screening criteria removed 41% of participants and 34% of non-participants from the sample. The remaining samples of 158 participants and 171 non-participants should be considered representative of the majority of households with reasonably stable usage patterns, not the entire population. The participants removed from the analysis tended to have higher spending on measures than those remaining ($847 vs $729/unit), implying that the sample may understate average program savings.

Results
The PRISM results were used to calculate average usage and savings levels for the participant and comparison groups. Net savings were calculated as the difference in average savings between the participant and the comparison groups. Standard t-tests were used to calculate 90% confidence intervals. The results of this analysis are summarized in Table 1 on the next page.

Table 1. Analysis Results: Mean Usage and Savings Levels
all values in kWh/yr unless otherwise noted

	Participant Group (n=158)	Comparison Group (n=171)	Net Savings
Pre-Program Normalized Usage (kWh/yr)	14,916	13,427	
Post-Program Normalized Usage	13,875	13,534	
Annual Savings	1,041	-107	1,148
Savings %	7.0%	-0.8%	7.7%
± 90% Confidence interval	±296	±221	±364
Savings - Houses Receiving Insulation (45)	1558		1664
Savings %	8.6%		9.2%
± 90% Confidence interval	±637		±536
Savings - Houses Not Receiving Insulation (113)	835		942
Savings %	6.1%		6.9%
± 90% Confidence interval	± 327		± 378

The average savings for participants was 1041 kWh/yr while comparison group households experienced an average usage increase of 107 kWh/yr, yielding a net savings of 1148 kWh/yr. The 90% confidence interval on this average net savings ranges from 784 to 1512 kWh/yr. Houses receiving insulation had approximately double the savings of houses which did not. All of these savings were highly statistically significant. The November 1995 impact evaluation found almost identical overall savings at 1150 kWh/yr, but higher insulation savings of 1928 and lower non-insulation savings of 733 kWh/yr. Program participant characteristics changed significantly over the time period. The current participant sample has 46% multifamily units, compared to only 15% in the previous evaluation. The average participant pre-treatment usage rate is 24% lower in this evaluation (14,916 kWh/yr vs. 19,687 kWh/yr in the prior evaluation and 21,502 in the evaluation before that). The frequency of air sealing and insulation work has also declined. Given these changes in the participant population, one would expect lower savings than found in the prior evaluation, but the results indicate that absolute savings levels have been maintained and percentage savings have increased.

Additional Analyses

Several additional analyses were performed to provide further insight into the program impacts and the evaluation methods.

Retail Affiliate & Housing Type Savings: The savings results were analyzed by retail affiliate and by housing type (single vs. multi-family). There were no statistically significant differences in savings for any retail affiliate, although customers of Fitchburg Gas and Electric Light had the highest average net savings (1445 kWh/yr) while those of Exeter and Hampton Electric had the lowest (975 kWh/yr). This pattern is the reverse of the previous evaluation. A comparison of multi- and single family customers found only a small savings difference (single family homes saved 1172 kWh/yr while multifamily units saved 1116 kWh/yr). This finding is somewhat surprising given the much lower pre-treatment usage rates in multifamily units (12,312 vs. 17,041 kWh/yr in single family). The installation of electronic thermostats in multifamily units may have contributed to their higher relative savings.

Median Analysis: The overall savings analysis was also performed using medians instead of means to ensure that the figures reported are not unduly influenced by outliers. This analysis found lower net savings, particularly for the uninsulated houses (705 kWh/yr overall, 1547 for insulated and 473 for not insulated). There were a significant number of participants with relatively large net savings (27% had greater than 2000 kWh/yr in savings and 15% saved more than 3000 kWh/yr).

Comparisons to Predicted Savings: Energy savings measured by the billing analysis averaged 65% of those predicted based on engineering algorithms (using a ratio estimate from the data on the 158 participants with both measured and predicted savings figures). This result is similar to the prior evaluation which found that 64% of predicted savings were realized.

Savings Persistence: Updated usage data on the participant and comparison samples from the November 1995 study were used to assess the persistence of program savings. A total of 304 (out of 324) prior evaluation participants and 278 (out of 304) prior comparison group cases had sufficient usage data for analysis. In order to maintain consistency, the new usage data was analyzed using the same method that was employed in the prior evaluation (a simple degree day adjustment approach). To provide for a full year analysis, the year 2 period was defined as July 1995 through June 1996, creating two summer months of overlap with the year 1 post-treatment analysis period (which was September 1994 through August 1995). The average weather-adjusted usage of prior participants increased by 125 kWh/yr during year 2, while the prior comparison sample's average usage increased by 135 kWh/yr. Therefore, net savings stayed about the same (actually increasing slightly by 10 kWh). This analysis indicates that savings have persisted through the second post-treatment year.

Conclusions

Overall, the Residential Space Heat Program achieved significant savings for its participants that compares reasonably well to similar programs operating in the region. The average net savings were 1148 kWh/yr with a 90% confidence interval ranging from 784 to 1512 kWh/yr. Households which received insulation averaged more than 1600 kWh/yr in savings. Households which did not receive insulation averaged about 900 kWh/yr savings. These savings were fairly consistent across housing types and regions.

The prevalence of supplemental heating sources caused the analysis to focus on households with reasonably stable usage patterns. Still, many customers included in the analysis experienced large changes in usage unrelated to the program. The impacts of such changes on impact evaluation results is difficult to estimate.